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2 July 1980

USSR Report

AGRICULTURE

(FOUO 5/80)

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POST HARVEST CROP PROCESSING

UDC 547.965

SCIENTIFIC CONFERENCE ON AMINO ACIDS FOR AGRICULTURE, FOOD INDUSTRY

Moscow VESTNIK AKADEMII NAUK SSSR in Russian No 4, 1980 pp 18-25

/Article by V.M. Belikov, doctor of chemical sciences, V.G. Debabov, doctor of biological sciences, and N.Ya. Tyuryayev, doctor of chemical sciences/

/Text/ Amino acids are the basis of all naturally occurring proteins and constitute the most important and irreplaceable part of the food of man and feed for livestock. The utilization of amino acids makes it possible to increase production and raise the quality of food products, while sharply increasing the efficiency of feed usage in animal husbandry. Possessing a high level of physiological activeness, amino acids are used to produce new, powerful medicinal preparations.

Joined by peptide bonds in more or less lengthy chains, amino acids provide the basis for peptides, enzymes, and all other proteins. Peptides, that is chains containing either a few or tens of amino acids, carry out regulatory functions in an organism, such as hormonal growth, food digestion, lactation, and many other processes. The longer amino acid chains form enzymes which act as catalysts in all biological processes, as well as the other proteins which perform the motive, structural, defensive, and other functions of an organism.

Thus, the chemistry and biochemistry of amino acids possess a fundamental significance for an understanding of the basis of life, for an understanding of the mechanisms of biological processes; moreover, amino acids have enormous possibilities for practical application.

Areas of application:

Mention should first be made of the use of amino acids for the synthesis of peptides, which are valuable pharmaceutical agents as well as a means for sharply increasing productivity in animal husbandry.

Amino acid compounds are finding broad application in the field of public health, primarily in diet therapy, but also in the diet of people engaged in heavy labor or subjected to high psychological and physiological stress, in particular, top-level athletes.

These amino acid compounds are widely employed as nutrient mediums for the growth of viral and microbial cultures, and for the cultivation of muscle and functional tissues, particularly blood-forming tissue.

The largest share of the world-wide production of amino acids is currently allotted to the food industry. To this end, production in 1977 amounted to more than 200,000 tons of mono-sodium glutamate--a flavoring and preservative, thousands of tons of aspartic acid and tens of tons of cysteine--commercial additives used in bread-making, thousands of tons of glycine--a sweetener for non-alcoholic beverages. Finally, the major part of the output of lysine was employed as a so-called balancing additive in bread.

Balancing additives, which bring the content of indispensable amino acids in food products up to the optimal level and optimal ratio, provide for a significant increase in the efficiency with which the proteins contained in these products are assimilated.

Animal husbandry has become an exceedingly promising field for the application of amino acids. Here they are used chiefly for balancing feeds. In table 1 are shown results of the balancing of the proteins contained in various plant products. Nutritive value is expressed as the coefficient of protein efficiency (KEB), that is, as the weight gain in experimental livestock, which is realized per gram of protein fed. Taken as the standard for comparison is the basic protein of milk--casein, the KEB of which is equivalent to 2.5.

Table 1

Results of balancing plant proteins
L-amino acids

Product	KEB initial	Balancing additive	KEB attained
Millet	0.3	0.5% lysine+0.2% threonine	2.5
Wheat	1.0	0.4% lysine+0.15% threonine	2.5
Corn	1.4	0.3% lysine+0.7% tryptophan	2.4
Rice	1.5	0.2% lysine+0.1% threonine	2.5
Oats	1.7	0.2% lysine+0.1% threonine	2.5
Sunflower	1.3	0.4% lysine+0.3% threonine	2.2
Cotton	1.7	0.1% lysine+0.3% threonine	2.6
Soybean	1.9	0.23% methionine*+0.23% lysine	2.8

* DL-methionine

The economic efficiency of feed balancing can be demonstrated by the example of L-lysine and DL-methionine. The addition of two to four kg of these amino acids per ton of feed mixture provides for a reduction of 15-20 percent in overall feed expenditure, with an accompanying increase in production output of roughly 20 percent. This means that if industry were able to establish current supply levels for livestock production at 50-60,000 tons of these amino acids for the enrichment of 20 million tons of feed mixtures, it would then be possible to realize additional meat production of around one million tons.

In this regard, it is interesting to compare the economic efficiency of the various chemical means employed in agriculture. Shown below are data concerning the value of additional commercial production per ton of the chemical means employed, less their inherent cost.

Mineral fertilizers	300 rubles per ton
Chemical agents for plant protection	3000-5000 rubles per ton
Amino acids	30,000 rubles per ton

These figures confirm the need for resolving the question of the optimal ratio of capital investments in the various areas of chemicalization in agriculture.

Finally, mention must be made of the important role of amino acids in scientific research, primarily in basic and applied research in the fields of biochemistry and molecular biology. It must be emphasized that the successful development of these promising directions in scientific research requires not only significant amounts of amino acids and their derivatives, but also a broad assortment of these substances at a reasonably high level of quality.

Status of production:

Within our country, the production of amino acids lags markedly behind the requirements of the national economy with respect to scale as well as to assortment and production quality, despite the fact that the economic efficiency of amino acid application, as shown above in the example with livestock production, may be quite high.

In accordance with the CC CPSU and USSR Council of Ministers resolution of 25 May 1978, "On further development of the production of feed additives, methods of plant protection, and other production in the microbiologics industry, 1978-1985," a program was instituted to increase the production output of the microbiologics industry, including amino acids. The introduction of new production capacities was envisaged for 1981-1985--in particular, a three to four-fold increase in the volume of lysine production. However, the demand in agriculture for this product is so great that even by 1985, the extent of satisfaction will amount to only 45 percent. In addition to lysine, both DL-methionine and mono-sodium glutamate are being produced in industrial quantities. Industry is confronted with an enormous task in providing for the amino acid needs of the national economy.

It should be noted that the data available to us concerning demand for these important products is often understated. Scientific estimations and universal experience confirm the fact that the effective dimensions of amino acid application should be significantly broader.

About 380,000 tons of amino acids were produced worldwide in 1977, which in everyday terms amounts to roughly one billion dollars. The major part of this production was achieved through the use of microbiological synthesis. Table 2 provides a representation of the dimensions and structure of worldwide production of all 20 amino acids which comprise naturally occurring proteins, and their important derivatives.

Table 2

Worlwide amino acid production in 1977

Amino acids	Production 1000 tons	Amino acids	Production 1000 tons
L-glutamic acid	250	L-leucine	0.05-0.1
DL-methionine	100	L-methionine	"
L-lysine-HCl	25	L-proline	"
Glycine	3	L-threonine	"
L-aspartic acid	0.5-1	L-tryptophan	"
L-glutamine	0.2-0.3	L-phenylalanine	"
L-arginine-HCl	0.2-0.3	L-cysteine	"
L-(2.4-dioxyphenyl) alanine (DOFA)	0.1-0.2	L-asparagine	0.01-0.05
L-alanine	0.05-0.1	L-isoleucine	"
L-valine	"	L-oxyproline	"
L-histidine-HCl	"	L-serine	"
		L-tyrosine	"
		L-cystine	"

To the above data may be added the fact that in 1979 the production of lysine grew to 50,000 tons, and glycine--to 7000 tons. From this, a representation of the rates of development in this field is easily drawn.

In accordance with the two primary means of amino acid synthesis--microbiological and chemical--their production is concentrated chiefly in the domestic enterprises of Glavmikrobioprom/Main Directorate for the Microbiological Industry/ and Minkhimprom/Ministry of the Chemical Industry/.

The bases of industrial microbiological production of amino acids, particularly lysine, were laid down as early as the beginning of the sixties at the Institute of Atomic Energy imeni I.V. Kurchatov with the pioneering work of academician A.P. Aleksandrov. In Glavmikrobioprom enterprises, lysine is presently manufactured in the form of a feed concentrate with approximately a 10 percent ground substance content. However, in universal practice, 98-99.8 percent pure crystalline lysine is recognized as the optimal form for use in animal husbandry, nutrition, and mdicine. In 1978, the manufacture of this product conforming to world standards was achieved in the USSR for the first time. Under development is a new technology with a capacity for producing crystalline lysine on the order of 2500 tons per year. In line with the organization of large-scale production of amino acids, a critical question arises with regard to expansion of the raw material base, particularly as concerns replacement of presently used molasses with an inedible material. The All-Union Scientific Research Institute of Genetics within Glavmikrobioprom has developed a new technology for obtaining lysine from acetic acid, which has reached the stage of experimental industrial production.

The technology of industrial production of mono-sodium glutamate was developed under the Glavmikrobioprom system for the USSR Ministry of the Food Industry. However, initial production at the plant assigned to manufacture this product has been delayed.

There is some experimental microbiological production of other amino acids (tryptophan, glutamic acid, leucine, isoleucine, threonine, proline) in minor amounts.

Also under development is the chemical production of amino acids.

Industrial production of DL-methionine from acrolein has been accomplished. The resultant product is used chiefly for poultry and livestock feeds. Methionine is subjected to partial purification and used as a pharmaceutical preparation.

The production of reactive amino acids for scientific research is gradually accelerating. In 1978, several plants under the Ministry of the Chemical Industry were engaged in the manufacture of 265 designated amino acids and their derivatives(including 15 of 20 naturally occurring L-amino acids), which exceeds even the demand projected four years ago for 1985(200 designated amino acids). However, both the quality and the quantity of this production are substantially inadequate. Many amino acids are produced in an amount totaling only a few grams. Moreover, their cost is still so high as to be unacceptable even for mere research into the possibilities of their application, not to mention broad practical utilization.

Development of new methods of synthesis:

In comparing long-range production development and projected demand, it can be seen that at present neither microbiology nor chemistry alone can provide for the amino acid needs of the national economy, particularly in view of the limitedness of the raw material base. It is therefore essential that all available investigative directions be pursued in the field of amino acid synthesis--both microbiological and chemical. Of course, the Academy of Sciences must actively participate in these efforts in cooperation with branch institutes of the various sectors.

The search for new types of raw material for synthesis and the development of more efficient and economic processes in the manufacture of amino acids must become the primary research objectives. At the present time, there is in this field a glut of uncompleted scientific and experimental-design projects, while collectives have been organized to deal with these problems, and many new and original processes have been developed.

Of all achievements in the field of microbiological synthesis, primary mention must belong to the work of the All-Union Scientific Research Institute of Genetics for the development of an unusually active strain of producers of amino acids such as lysine, tryptophan, threonine, glutamic acid, and others through the application of modern methods in the field of genetics. Using methods involving the isolation of auxotrophic and regulator mutants, scientific research is being expanded in the area of developing new, highly efficient amino acid-producing microorganisms with industrial applications. Among the achievements of recent years is the development through intricate selection methods of an isoleucine strain which is one of the most active producers of this amino acid known in the world. Through genetic research, regulator mutants have been isolated which are capable of direct synthesis of tryptophan in structurally simple nutrient media, without the need to introduce a precursor.

At the All-Union Scientific Research Institute of Genetics, an essentially new approach was worked out for the development of amino acid-producing strains based on the use of genetic engineering techniques. Already developed by such methods is a threonine-producing strain. This extremely interesting and pioneering work is the sole example in the USSR of the practical application of a synthetic strain which has been artificially altered by the implantation of the needed genes. It's growth rate exceeds that of foreign specimens by a factor of 2.5.

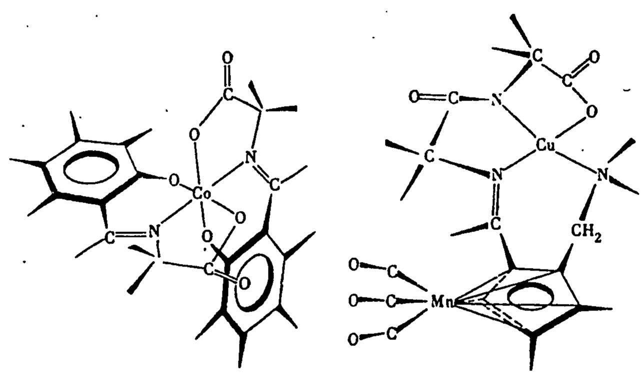
The State Institute of Applied Chemistry(GIPKh) of the USSR Ministry of the Chemical Industry, together with a number of other institutes, most notably the Institute of Hetero-organic Compounds(INEOS) of the USSR Academy of Sciences, and the Moscow Chemical-Technological Institute imeni D.I. Mendeleyev, has developed an original technological process for obtaining L-lysine from cyclohexanone, L-glutamic acid from acrylonitryl, as well as L-tryptophan from nitroacetic ester and indole. Wide-spread testing of synthetic L-lysine in fattening programs for hogs, chicks, and calves did not reveal a difference from the lysine obtained from other sources. The total experimental production of the GIPKh provides up to 50 kg per year of the various amino acids for testing. The ministry has laid down the technical and economic bases for the design of experimental and industrial production of the aforementioned products; their economic indicators correspond to standards established by the USSR Gosstroy and USSR Gosplan. Unfortunately, however, problems concerning the organization of experimental and industrial production of lysine, glutamic acid, and tryptophan have yet to be resolved by the ministry.

The Institute of Organic Chemistry of the USSR Academy of Sciences has made a detailed study of the process of asymmetric synthesis of L-phenylalanine, and has developed a method for employing it.

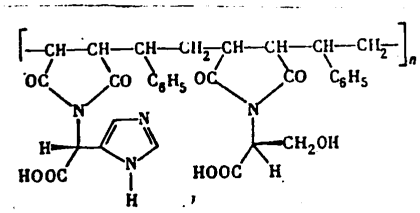
The INEOS has worked out a gneral method for the synthesis of amino acids from nitromethane(tryptophan, DOFA, phenylalanine, tyrosine, leucine, isoleucine, valine, threonine, and glycine).

Particularly noteworthy is the development of a series of syntheses from glycine, interesting for the fact that very nearly quantitative asymmetric results were obtained by employing techniques of coordination chemistry. These reactions(termed biomimetic)simulated the principles of operation of enzymes which catalyze reactions in living organisms.

As specific examples of structures synthesized at the INEOS, which imitate the action of natural enzymes, the author has presented sterochemical models based on the metalline complexes containing cobalt and copper. They employ the catalytic principles of natural pyridoxal enzymes and are able to achieve asymmetric synthesis of amino acids.



Furthermore, the author has introduced the formula for the newly developed synthetic macromolecular model of the proteases--natural enzymes which catalyze such essential reactions for the production of amino acids as the hydrolysis of proteins:



This catalyst is remarkable for the fact that it maintains its activity even at 100°C.

Subsequently the author noted that the INEOS, in conjunction with the Institute of the Technology of Blood Substitutes and Hormone Preparations of the Ministry of the Medical Industry, has developed a promising process for hydrolysis of a biomass of microorganisms with the use of proteolytic enzymes. The resulting amino acid preparation, "Autolysine," may find wide application.

Lastly, the author discussed the INEOS-synthesized coordination systems capable of attaining one of the most important stages in the synthesis of amino acids--the segmentation of racemates and the racemization of D-isomers by a completely original method--the chromatographic process; also discussed were low-molecular and polymeric systems which accomplish catalytic racemization of D-isomers with the aid of natural enzymes.

Many of the specific developments of the INEOS have been passed along to industry.

No doubt there is major importance in the determination of the specifics of the interaction of amino acids with coordination compounds and their modifications during coordination. Addressing themselves to this task is a team of researchers at the USSR Academy of Sciences Institute of General and Inorganic Chemistry imeni N.S. Kurnakov. Here, the primary focus is on the broad development of research into coordination and metalloorganic bonds with amino acids of dissimilar structure, which underlies the development of methods complex chemical isolation of amino acids from compounds and their subsequent purification. The study of the stereochemistry of such bonds, particularly with the help of modern chirotypical methods, will assure the development of methods for the stereospecific synthesis of optically pure amino acids in coordination bonded matrices.

As stated previously, despite the enormous national economic importance and high economic efficiency of amino acid production, it does not in any way measure up to demands for it in agriculture, the food industry, the fields of public health and science, and these very demands are in fact understated.

One of the reasons for this is the slow rate of development of scientifically sound standards for amino acids and recomendations for their use in the abovementioned fields, as well as in technical engineering and peptide synthesis, in view of which it is difficult to determine actual demand. But these standards and recommendations can be worked out only on the basis of testing of a large number standardized preparations, the accomplishment of which, for its part, depends on a sufficiently large amount of experimental-industrial production.

In order to break up this vicious cycle, rededication is needed in the joint efforts of chemists, microbiologists, and specialists in the fields of agriculture, public health, and the food industry, with the aim of developing the requisite standards and recommendations, as well as the optimal framework of capital investments in agrochemical practices.

During a review of this report, USSR Academy of Sciences member-correspondent, V.S. Shpak, pointed out that until relatively recently, amino acids were produced in industrial quantities only by the microbiological method. As of late, the GIPKh has fully developed technological processes for obtaining a number of important amino acids. The Minkhimprom considers development of the amino acid industry a matter of enormous importance for the entire national economy.

The need to develop a complex scientific-technical program in this area in conjunction with all interested departments is quite apparent.

Quite recently, as Shpak stated, we consulted with the director of the Glavmikrobioprom on how to expedite a solution to this problem. Even now we could draw up for the Presidium of the USSR Academy of Sciences a proposal to the government that the production of amino acids be raised to a level of at least 100,000 tons per year. Estimates indicate that capital investments in this area are recouped in even less than a year's time.

The attitude of the consumer and the extent of his readiness for the use of amino acids constitute a serious problem.

The deputy chairman of the Glavmikrobioprom Scientific-Technical Council, I.I. Dikovskiy, has emphasized that the overriding problem of microbiological production of amino acids has been and remains the lack of a domestic supply of sufficient volume and strength, and of a quality adequate to ensure the sterile conditions under which the process is conducted.

In comparing the possibilities of the chemical and microbiological methods of obtaining amino acids, Dikovskiy took note of the fact that the latter remains significantly more cost-effective. Despite the simplicity of the production process itself, and the much lower cost and greater availability of raw materials, the chemical method allows production of only the DL-configuration of amino acids. The difficulty of isolating the D- and L- forms far outweighs all gains in efficiency in the initial stage. Along with this, it is essential that new, progressive methods of isolating the D- and L- forms be given consideration; some of these, in particular, the author has discussed in this report. In exploiting the advantages of both methods, chemists and microbiologists, having joined forces under the aegis of the Academy of Sciences, can develop economically profitable processes for the production of amino acids in large quantities.

Dikovskiy further revealed that the demand for amino acids in agriculture was recently determined and confirmed for each year up to 1990.

Summing up the discussion, the president of the USSR Academy of Sciences, academician A.P. Aleksandrov, directed attention to the significant gap between science and industry in the area of amino acid synthesis.

There is no doubt, as he stated, that the development of amino acid production is a problem of extraordinary importance for the nation. It is essential that this problem be assigned particular exigency and that it receive serious consideration within the Academy of Sciences, with the mandatory attendance of representatives of Glavmikrobioprom and the Ministry of the Chemical Industry.

The purpose of said consideration should be the preparation of joint proposals concerning measures for developing amino acid production.

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LIVESTOCK

ACCOUNTING PRICES, INTERENTERPRISE COOPERATION IN ANIMAL HUSBANDRY

Moscow VOPROSY EKONOMIKI in Russian No 2, Feb 80 pp 130-136

[Article by P. Meshcheryakov: "Calculated Prices in Interfarm Animal Husbandry Cooperation"]

[Text] With interfarm cooperation in animal husbandry production there is considerably greater exchange among individual farms of such products as feed, young animals and so forth, and the role of stage-by-stage specialization increases (reproduction, completion of raising, fattening). The creation of new production units and associations as well as progressive technical equipment and technology complicate the practice of economic ties. Here the application of calculated prices for products in interfarm circulation is preferable to other forms of accounting. The utilization of the price mechanism makes it possible to stimulate the development of production since the price not only reimburses the farms for the expenditures they have made, but also transfers part of the pure profit created in the association.

The formation of prices for goods in interfarm circulation should proceed from the need to create approximately equal possibilities of expanded reproduction for all participants in the cooperation. When there is specialization in various individual objects, the collective motivation for the development of production is achieved by providing for equal profitability (the profit as compared to production costs). As calculations show, the profitability of production, calculated on the basis of the distribution of profit in proportion to fixed capital or expenditures on live labor, remains the same in practice. This method was constructed on the principle of compensation, whereby the economic results of each member in the cooperation for producing products on an interfarm basis correspond to the results of the activity of the interfarm formation as a whole.

With stage-by-stage specialization the distribution of profit in order to create equal opportunities for expanded reproduction can not be made in proportion to the production cost, fixed capital or expenditure of live labor. In the first place, in the early stages it is necessary to have more rapid rates of expansion of production (as a guarantee of a fuller load on production capacities on subsequent stages. In the second place, the utilization of a large mass of circulating capital in subsequent and final stages of production with proportional distribution of profit creates conditions for obtaining a volume of profit which is not necessary for expansion or economic stimulation of production. For example, when the profitability of the reproduction hog farms is 63 percent and fattening farms, 21 percent, the profit that is obtained makes it possible to maintain normal rates of expanded reproduction and equal material incentives for the collectives of these farms.[1]

In order for the proportions necessary for expanded reproduction in each stage of production to be more fully reflected in the calculated price, one should use the indicator of the structural coefficient in terms of capital-intensiveness. The amounts of the funds are adjusted (weighted) by the amount of the structural coefficient in keeping with the differential proportional capital-intensiveness of the output from each stage of production. The overall sum of the association's profit is distributed among the various stages of production in proportion to the overall sum of production costs, adjusted by the structural coefficient of the volume of capital. The structural coefficient for capital-intensiveness is calculated as the ratio between the capital-intensiveness of the products from various stages of production and the capital-intensiveness of the prepared (final) product, taken as a unit. For example, the capital-intensiveness of products of hog raising at the Kuznetsov hog complex in Narofominskiy Rayon in Moscow Oblast amounts to the following in the various stages: reproduction--1.48; completion of raising--0.63; fattening--0.54, and the prepared product--0.62. Then the structural coefficient for capital-intensiveness will be equal to the following for the various stages: reproduction--2.39 (1.48; 0.62); completion of raising--1.02 (0.63; 0.62); fattening--0.73 (0.45; 0.62).

The profit per unit of expenditures, taking into account the structural coefficient for capital-intensiveness is determined from the formula:

$$K_{\text{Ф}} = \frac{П_0}{\Sigma\,(Q_{ij} + Ф_{ij} \times P_{ij} \times T_i)},$$

where $П_0$ --branch profit for cooperation (association); Q_{ij}--the sum of expenditures in i stage for producing j product; $Ф_{ij}$ --branch capital in i stage; P_{ij} --structural coefficient for capital-intensiveness; and T_i --growth rate.

The total profit in i stage will be $П_i = (Q_{ij} + Ф_{ij} \times P_{ij} \times T_i) \times K_{\text{Ф}}$.

We did a methodological calculation to establish calculated prices for products in each stage of port production. The following indicators of production profitability were obtained for individual stages: taking into account the structural coefficient for capital-intensiveness (in the stage of reproduction--68 percent, completion of raising--35 percent, fattening--34 percent); without taking into account the structural coefficient for capital-intensiveness, that is, the distribution of profit in terms of the total sum of expenditures (production costs) and fixed capital (in the stage of reproduction--41 percent, completion of raising--37 percent, fattening--39 percent). Thus production profitability in the stage of reproduction without taking into account the coefficient ( ) is equal to 41 percent as against 39 percent in fattening, while the profitability in the stage of reproduction is twice as great as in the stage of fattening when this coefficient is not taken into account.

Calculated prices are established for products in interfarm circulation within the limits of the payments for the prepared (final) products sold by the cooperation organization to the state at procurement prices that are established taking into account increments for quality and other conditions of sale. When selling the prepared products (fattened livestock and so forth) the association receives pure income (profit) which is distributed among the participants in the production. When selling non-commercial products (feed, young animals for replenishing the herd and so forth) within the association among the shareholding farms, the pure income is not realized, although it is created both when producing products that have commercial importance for the national economy and those that have no commercial importance but are necessary for raising and fattening livestock (feed) and augmenting the herd (non-calving young cows, first heifers). The pure income created in non-commercial branches of agricultural production is realized in the zonal procurement prices for the commercial products.

An agricultural association should redistribute the pure profit it obtains from the sale of products to the state not only among direct participants in the production of a given product, but also among the collectives that do not independently carry out commercial production, but contribute to the prepared product indirectly through the results of their economic activity. Herein lies the essence of the mutually advantageous economic relations through calculated prices. Improvement of the mechanism for the operation of calculated prices through including in the calculated price for non-commercial products (feed, young animals) the profit, which creates conditions of normal development of production in all stages (sections) strengthens the collective incentive to increase pure income and to increase the production of the final product.

With cooperation in breeding large-horned cattle the calculated prices are formed taking into account more complicated production relations than in hog raising. One must take into account that dairy and meat cattle raising are economically, organizationally and technologically independent branches of animal husbandry and the procurement and processing of their products (milk, meat) are carried out by different branches of industry. When these products are produced the pure income (profit) created in each of the aforementioned sub-branches is realized. Pure income from the sale of milk to the state is not related to the pure income that is received from the sale of high-quality young animals. What we have said justifys considering the process of reproduction in cattle raising not as a single, but as a dual complex process: the first--increasing the production of young animals and milk, and the second--increasing the production of adult livestock.

When cooperating in milk production one specializes in various items (the good are young animals, milk and feed). Here the motivation to organize an interfarm association, to develop specialization, to introduce the latest technology and, on the basis of this, to increase production efficiency is achieved through the distribution of the realized pure income from the sale of milk to the state in proportion to the total cost of the production of milk, feeds, and young animals. This takes place in any kind of cooperation where there is specialization in individual items.

The technological process of raising adult large-horned cattle is differentiated in terms of the areas of their further utilization. The conditions for maintaining young animals intended for replenishing the herd are different from the conditions for maintaining young animals for fattening. This is also specialization in individual items where two commodities are produced: non-calving young cows and young animals for slaughtering. The processes of producing non-calving young cows for dairy farms and fattening young animals for slaughtering are carried out on the model of stage-by-stage specialization--raising, completion of raising and fattening. Thus in one and the same process of reproduction the adult cattle simultaneously participate in both kinds of specialization: specialization in individual items and stage-by-stage specialization. There are a number of recommendations which are not completely developed on the methodological plane regarding this economic and technological process. Some economists do not make distinctions in the methods of forming calculated prices with different kinds of specialization,[2] and others do not draw a clear distinction between calculated and release prices,[3] while still others recommend establishing a stable profitability norm for farms specializing in the raising of non-calving young cows.[4]

Under the conditions of the development of large-scale, narrowly specialized production, calculated prices for agricultural goods can not be formed without taking into account the type of specialization: organizational (individual items) and technological (stage-by-stage) and orient procurement prices with reference to the general economic profitability of the multibranch enterprise and not with reference to the extensive development of specialization, whereby commodity profitability acquires independent significance. One should also not establish a stable profitability norm for an individual interfarm enterprise in multibranch production since this makes it possible for it to function by using the profit obtained by the interfarm enterprise as whole and not its own accumulations. This does not motivate the enterprise to deepen specialization or to expand cooperation.

It is also incorrect to orient the profitability of narrowly specialized interfarm enterprises of one of the sub-branches of livestock raising with reference to the average weighted profitability of livestock raising as a whole. The motivation of these participants in the cooperation to increase production is achieved by providing them with those sums of profits which create equal opportunities for expanded reproduction, the formation of economic incentive funds and improvement of production in keeping with the planned rates. The only commercial product for the national economy in the complex of reproducing adult large-horned cattle is the cattle that are fattened for slaughtering. The pure income (profit) created by collectives of complexes for non-calving young cows and fattening complexes through sales to the state is the only source for the formation of economic incentive funds and the necessary accumulations in both of these complexes.

The overall sum of profit from the sale of fattened young animals to the state is determined as the difference between the cost of the sold livestock at existing prices and its production cost (see table).

Table. Expenditures on Raising Young Animals*

Indicators	Units of measurement	Complex for non-calving young cows	Fattening complex
Number of calves delivered	head	5,000	10,000
Overall weight gain of young animals in stage of raising	quintals	5,000	10,000
Cost of all weight gain in stage of raising	thousands of rubles	862.5	1,525
Including:			
cost of feeds	thousands of rubles	505	905
Overall weight gain of young animals	quintals	11,250	22,500
Cost of all weight gain in stage of completion of raising	thousands of rubles	1,575	2,700
Including:			
cost of feeds	"	941.3	1,942.5
Cost of all weight gain during stages of raising and completion of raising	"	2,437.5	4,225
Cost of all weight gain during period of raising, completion of raising and fattening	"		5,215
Including:			
cost of feeds	"		3,612.5

*Initial data of average association (in the Nonchernozem zone), in round figures: number of head of cows and noncalving young cows at beginning of year--15,000; average milk yield from 1 cow--3,500 kilograms; and average sales price per 1 quintal of milk--21 rubles.

The overall lived weight of animals that are taken from fattening amounts to 45,000 quintals, including the delivery weight of cows--3,500 quintals, the weight gain in the stage of raising--10,000 quintals, the weight gain in the stage of completion of raising--22,500 quintals, and the weight gain in the stage of fattening--9,000 quintals. The complete production cost is 6,501,000 rubles, of which the cost of the calves that are delivered is

1,286,000 rubles and the internal expenditures of the fattening complex are 5,215,000 rubles. With an average sales price of one quintal of live weight of young animals being 192.2 rubles the earnings equal 8,649,000 rubles (45,000 X 192.2) and the profit is 2,148,000 rubles (8,649 - 6,501). This profit is obtained in the stage of reproduction of the adult large-horned cattle by collectives of complexes for noncalving young cows and fattening complexes and therefore it should be distributed among them in proportion to their internal expenditures. The internal expenditures for raising young animals to replenish the herd in the complex for non-calving young cows (including feed production) and young animals raised in excess of the number needed for replenishing the herd in the fattening complex are equal to 7,652,500 rubles (2,437,500 + 5,215,000), including the production cost of feeds that are used which amounts to 5,058,800 rubles (1,446,300 + 3,612,500). The profitability of the entire production amounts to 28.1 percent (2,148,000:7,652,500).

The profit that goes to workers of the complex for noncalving young cows (including feed production) is equal to 684,000 rubles (2,437,500 X 28.07) and of the fattening complex--1,464,000 (5,215,000 X 28.07). As was mentioned above, in the process of reproduction of large-horned cattle there are two kinds of specialization (in individual items and stage-by-stage). The principle of equal distribution of pure income according to the expenditures of the participants in the cooperation is fair under the conditions of specialization in individual items, which is to be found in the reproduction of young animals for replenishing the herd and fattening them. The profit obtained from raising all of the young animals (2,148,000 rubles) is distributed among the complexes for noncalving young cows and the fattening complexes in proportion to their expenditures (684,000 rubles and 1,464,000 rubles). In the process of producing noncalving young cows and young animals for slaughter itself there is stage-by-stage specialization where the distribution of the calculated profits (684,000 rubles and 1,464,000 rubles) in proportion to the expenditures in each stage (raising, completion of raising, fattening) does not contribute to uniform stimulation of production in each of the stages. This profit is distributed among the various stages of production of the young animals for replenishing the herd and those raised in excess of the amount necessary for this in order to establish calculated prices for the products, taking into account the coeffient P_{ij}. To do this it is necessary to calculate the structural coefficient in terms of capital-intensiveness and to adjust (weight) it by the amount of fixed capital in the various stages of production. The profit in the complexes will be distributed among the stages of production in the following way (thousands of rubles):

	Complex for non-calving young cows	Fattening complex
Raising	319	575
Completion of raising	365	691
Fattening		198

The calculated prices for the products from each stage of production are determined according to the formula

$$Ц_{ij} = \frac{Q_{ij} + П_{ij}}{B_{ij}},$$

where $Ц_{ij}$ --the calculated price per unit of j-product from i-stage of production; Q_{ij}--the volume of expenditures in i-stage of production of j-product; B_{ij}--the amount of production of j-product in i-stage in physical units; $П_{ij}$ --the profit from i-stage of production of j-product.

The prices calculated according to this formula for one quintal of product in the various stages amount to (in rubles):

	Complex for non-calving young cows	Fattening complex
Raising	236.3	210
Completion of raising	172.4	150.7
Fattening		132

Here the release price of one calf after the stage of raising with a weight of 135 kilograms (35 kilograms delivery weight and 100 kilograms of weight gain) will be 354.3 rubles (118 + 236.3), and the release price of one noncalving young cow after the stage of completion of raising with a weight gain of 3.6 quintals is equal to 742.3 rubles, of which 354.3 rubles is the price of the delivery weight and 388 rubles is the price of the weight gain (2.25 quintals) during the completion of raising. The release price of one quintal of live weight of noncalving young cows will be equal to 206.2 rubles (742.3:3.6).

It should be noted that to confuse the concepts "calculated price" and "release price" in practice leads to pumping the distributed profit from products produced in various stages of production (for example, reproduction) into the products that are created in the final stages (fattening) and thus reduces the incentive for cooperative production. The calculated price reflects the increasing accounting-distributive and stimulating role of the price in production and becomes a form of distribution of profit in cooperative production while the release price is only the weighted amount of the calculated prices of the various stages.

In the opinion of a number of economists, the calculated (or release) price for calves and noncalving young cows raised at interfarm enterprises should include an increment not only for the grade category (development), but also for the breed category (origin). There is no doubt about the need for an increment for the grade category since it depends upon the quality of the work of the farm, the conditions for the maintenance, feeding and care for the young animals to replenish the herd. The application of increments for the breed category under the conditions of interfarm associations, in our opinion, is inexpedient. Breeding work conducted on farms of the association is based on the selection of young animals from those that are available in order to augment the basic herd, which is the best way to carry out the tasks facing the kolkhozes and sovkhozes for increasing the production of high-quality and inexpensive products for the national economy. Interfarm enterprises that raise young animals of high conditions to replenish the herd in the quantities necessary for all participants in the association should not use list prices for thoroughbred and improved livestock (or ratio of prices for them) when evaluating the young animals raised for the farms of their own association.

Increments for breeding qualities should be introduced in scientific production associations for animal breeding. There is now a need to create new, highly productive lines, families and breeds of livestock that fully meet the requirements of industrial production technology for animal husbandry products. In order to stimulate the creation of such herds, it would be expedient to apply list prices (or ratios of prices) for breeding animals within the association.

The difference between the procurement and calculated price for a fattening enterprise is reflected in its bookkeeping accounts as expenditures to pay for young animals of the farm for the completion of raising. The profitability of production (in terms of production costs) in a fattening complex amounts to: in the stage of raising--37.7 percent, in the stage of completion of raising--35.6 percent, and in the stage of fattening--20 percent.

The profitability in the stage of raising is almost twice (1.9) as great as in the stage of fattening. If the profit were distributed without taking into account the structural coefficient for capital-intensiveness (from the sum of production costs and fixed capital), the profitability for the aforementioned stages would be: 31 percent, 28 percent and 24 percent, that is, the difference is profitability is not significant (1.3-fold). Calculated prices per one quintal of product in these stages would be: 200.5 rubles, 153.2 rubles and 136 rubles. The difference in the prices is insignificant --4-10 rubles per one quintal. But because the mass of circulating capital is greater in subsequent stages than in the first stage, 95,000 rubles are withdrawn from the profit obtained in the first stage (575-480), or almost one-fifth of it, which has a negative effect on the stimulation of expanded reproduction.

Prices that are constructed taking into account only internal expenditures and a small proportion of surplus product (profit) without including a certain part of the surplus product from revenues obtained as a result of the division of labor and specialization do not create economic incentive for the cooperating farms to expand and deepen specialization and concentration on an interfarm basis. When improving economic relations on the basis of calculated prices within interfarm associations, one should observe the policy for the distribution of profit among collectives according to their own expenditures without including the cost of products and services that come from the outside.

FOOTNOTES

1. "Penzenskiye zhivotnovodcheskiye kompleksy" [Penzenskaya Oblast Animal Husbandry Complexes], Izdatel'stvo "Kolos," 1973, p 213.

2. See A. Chursin, "Calculated Prices for Cattle, Poultry and Feed," DKONOMIKA SEL'SKOGO KHOZYAYSTVA, No 2, 1978.

3. See A. A. Omel'yanenko and Yu. D. Shapovalov, "Experience in Determining Calculated Prices for Young Cattle Under Conditions of Interfarm Cooperation," UCHET I FINANSY V KOLKHOZAKH I SOVKHOZAKH, No 12, 1977.

4. See V. Frolov, "Calculated Prices for Long Horned Cattle to Replenish the Herd," EKONOMIKA SEL'SKOGO KHOZYAYSTVA, No 4, 1978; A. I. Yesin, "Vzaimootnosheniya uchastnikov mezhkhozyaystvennogo kooperirovaniya" [Interrelations of Participants in Interfarm Cooperation], Izdatel'stvo "Ekonomika," 1977.

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LIVESTOCK

PROGRESS, PROBLEMS IN KAZAKH LIVESTOCK COMPLEXES DISCUSSED

Alma-Ata SEL'SKOYE KHOZYAYSTVO KAZAKHSTANA in Russian No 3, Mar 80 pp 20-21

[Article by T. Dzhakupov, chief of the sector for the location of animal husbandry complexes of the Kazakh Scientific Research Institute of Economics of Agriculture, candidate of agricultural sciences, honored economist of the Kazakh SSR: "A Comprehensive Program for Development of the Branch"]

[Text] Industrialization of animal husbandry is a most important constituent part of the comprehensive program for the development of agriculture which was developed and subsequently implemented by the Communist Party. The work experience of consolidated animal husbandry complexes convincingly confirms their undisputed advantage in essentially increasing production efficiency. Therefore in Kazakhstan, as in other republics of the country, a large amount of attention is being devoted to the expansion of the network of large complexes for producing milk, beef, pork and mutton, as well as to goal-directed raising of non-calving young cows. There are more than 450 animal husbandry complexes and fattening areas in operation in the republic. By the end of this five-year plan (taking into account those under construction), there are to be about 680 of them.

The production of meat, milk and other animal husbandry products on an industrial basis has made it possible significantly to increase labor productivity, to reduce expenditures per unit of output, to reduce production costs and to increase the economic efficiency of the production as a whole. Thus in places where the creation of an optimal feed base was taken into account when planning the construction of complexes, good indicators were achieved. For example, in the dairy complex of the Kolkhoz imeni 30-letiya Kazakh SSR in Pavlodarskoy Oblast, where they organized a green conveyor on land that was irrigated by underground waters, relatively good results were achieved. Here in 1978 the average milk yield from the cows was about 3,000 kilograms, the production cost of a quintal of output--22.47 rubles, the expenditure of feeds per quintal of milk--1.08 quintals of feed units, and labor expenditures--6.5 man-hours.

But the assimilation of the planned capacities of dairy complexes is still proceeding slowly on the whole. Many of them have not been fully provided with animals of the appropriate productivity. Thus in 1978 in Alma-Atinskaya Oblast the dairy complexes had only 57.8 percent of the necessary animals, Tselinogradskaya--77.7 percent, Pavlodarskaya--42.9 percent, and in the republic as a whole--70 percent. It is not surprising that the productivity of the cows here amounted to an average of 2,268 kilograms. Expenditures of labor and feeds per unit of output were extremely high: on an average per quintal of milk they amounted to 7.2 man-hours and 1.66 quintals of feed units with the cost of the feed averaging up to 30.25 rubles. The indicators of the dairy complexes of the Chernoretskiy and Zarya Sovkhozes in Pavlodarskaya Oblast are extremely typical in this respect. Their profitability levels were 31 and 36 percent.

The work experience of complexes for producing beef showed that, despite the large capital investments in their construction, they make it possible to produce their products with optimal expenditures of labor and material funds. Thus the high concentration of animals and the possibility of extensive application of the achievements of science and advanced practice made it possible at the Dzhetygenskiy Complex to increase the average daily weight gain of young animals to 937 grams in 1978 while the average for sovkhozes of Alma-Atinskaya Oblast was 351 grams, to reduce the expenditures of feed per quintals of weight gain 2.5-3-fold, to reduce production outlays per unit of output by 30-35 percent, and to increase labor productivity 8-10-fold as compared to the usual technology on the farms of the kolkhozes and sovkhozes. This high efficiency of beef production was also achieved at fattening areas of the Zhelayevskiy Rayon specialized farming association. But because of the fact that they were late in solving a number of organizational problems, the complexes and fattening areas, in terms of certain indicators, did not promptly reach the calculated parameters for average daily weight gain, release weight or level of profitability. Up to this point, for example, the planned capacity of the Dzhetygenskiy Complex has been reached only by 92 percent, despite the undoubted successes of this complex.

The development of complexes for producing pork is proceeding more rapidly. The Iliyskiy Complex in Alma Atinskaya Oblast, the Efremovskiy in Pavlodarskaya, and the Volynskiy in Karagandinskaya Oblast are operating relatively well. They are producing more than 35 percent of all the pork that is produced on complexes of the republic. The production cost per quintal of weight gain is the lowest--78-100 rubles. But not all the complexes that are in operation for producing pork coordinate their work with reproduction farms, as a result of which the young animals do not arrive regularly and they are frequently substandard, which impedes the cycle of work of the complexes and is one of the main reasons for the delay in reaching the planned capacities.

The majority of sheep raising farms of the republic are fairly large enterprises and therefore they have the opportunity to organize mechanized feeding areas to accomodate 5,000 and 10,000 on the basis of interfarm specialization. But it is expedient to create this type of interfarm enterprise only in places where the concentration of sheep makes it impossible to organize large fattening areas directly on the farms.

Practice shows that we have not been able to avoid serious shortcomings in the construction and operation of animal husbandry complexes and fattening areas in the republic. This makes it necessary, when designing and constructing them, to solve a large group of problems simultaneously, important ones being:

scientifically substantiated distribution of animal husbandry complexes and fattening areas, and expansion and renovation of mechanized farms with a clear determination of the reproduction and fattening farms and an optimal radius for the delivery of young animals;

the creation of a herd that meets the requirements of industrial technology through directed raising of young animals on specialized farms and complexes;

reorganization of the feed base, providing full-value and inexpensive feeds for the planned number of animals, in the assimilation of the planned capacities of the complexes through compulsory planning of feed production with irrigated fields;

optimal determination of financial and economic relations and mutual accounts among cooperating farms;

planned training of skilled personnel in special courses within the system of vocational and technical education on the basis of study in conditions under which one must work in the complexes.

The scheme for the development and distribution of animal husbandry complexes under the Eleventh Five-Year Plan, which was first developed in the republic with the extensive participation of planning (construction, water, management, land construction) and scientific research institutes and agricultural agencies, determines the future level of production of animal husbandry products on an industrial basis, the construction of new complexes, the expansion and renovation of existing fattening areas and mechanized farms, and their scientifically substantiated distribution, the final goal of which is the formation of specialized farms for producing milk, beef, pork and mutton as a constituent part of the development, distribution and specialization of agricultural production.

At the basis of the development of the scheme lie the decisions of the 25th party congress, the 14th congress of the Communist Party of Kazakhstan, and the corresponding plenums of the CPSU Central Committee and the Central

Committee of the Communist Party of Kazakhstan. Under the Eleventh Five-Year Plan it is intended to construction 94 complexes for producing milk with a capacity of 52,000 cows (400-800 cows each), 24 for raising non-calving young cows--to accomodate 72,000, 37 fattening areas and complexes for producing beef--to accomodate 198,000 head, 17 complexes for producing pork--to accomodate 403,000 head, and 149 fattening areas and comprehensively mechanized farms for producing mutton--to accomodate 731,000 sheep.

All this will make it possible by the end of 1985 to increase the proportion of the production of milk on an industrial basis in the public sector by almost 15 percent, beef--by more than 22 percent, and pork--in the range of 36 percent. Moreover there will be a significant improvement in the economic indicators for the production of animal husbandry products on an industrial basis. In particular, the production cost of a quintal of milk at dairy complexes on an average for the republic (calculated) will amount to 16.2 rubles, the profitability level will be 78.2 percent, the production cost of a quintal of beef at complexes and fattening areas--82.3 rubles, the profitability level--82 percent, the production cost of pork--89.9 rubles, and the profitability level--68 percent. There will also be an increase in the efficiency of the production of sheep raising products. The overall savings on production expenditures (in terms of production costs) as compared to the level of sovkhoz and kolkhoz farms will amount to 168 million rubles by 1985, the profit from the sale of products will be about 348 million rubles, and 27,000 average annual workers will be released.

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TILLING AND CROPPING TECHNOLOGY

REACTION OF WINTER WHEAT TO TIME OF RESUMPTION OF SPRING VEGETATION

Kiev PSHENITSA in Russian 1977 pp 63-73

[Excerpt from book compiled by K. V. Malusha and A. K. Medvedovskiy: "Wheat"]

[Text] Unlike spring wheat, there is a period of winter dormancy after the tillering stage of winter wheat. Resumption of spring vegetation occurs when mean daily air temperature goes beyond 0 and 5°C. This phenological phase is observed when there is 1 cm growth of new plant tissue.

In the European part of the USSR, according to data covering many years for various strain-testing stations, spring vegetation of wheat occurs as follows: on 15 March in the region of Nal'chik, 23 March in Crimea, 29 March in Poltava, 8 April in Belgorod, 17 April in Tula and 28 April in Vologda. There are even wider fluctuations (50-60 days) of time of resumption of spring vegetation in the same region in different years (Table 40).

Wintering plants present a certain reaction to the time of resumption of spring vegetation (V. D. Medinets, 1968, 1972), and this affects their subsequent growth and development. Knowledge about this phenomenon broadens the possibility of controlling productivity of wintering plants, including winter wheat, under specific conditions during the spring and summer.

The time of resumption of vegetation affects regenerative processes, onset of developmental phases and stages of organogenesis, formation of plant density, area of leaf surface, photosynthetic activity of plants, their resistance to lodging, correlation between mass of vegetative and reproductive organs, ultimate productivity, structure of harvest, accumulation in plants and grain of protein and gluten, as well as formation of other grain qualities.

The influence of the time of resumption of spring vegetation on wheat growth is demonstrable immediately after "waking" in the spring. The plants that sprout earlier are subject to more intensive tillering and rooting than later ones.

Table 40. Date of spring vegetation of zoned cultivars over a 25-year period (1945-1970), temperatures in the spring and winter of these years

Oblast, republic	Strain-testing station	Start of spring vegetation		A		B	
		E	L	E	L	E	L
Khersonskaya	Vysokopol'skiy	13.II.66	3.IV.48	9,1	14,0	100	67,6
Zakarpatskaya	Mukachevskiy	16.II.66	26.III.63	10,0	12,0	100	98,5
Brestskaya	D.Gorodokskiy	18.III.61	24.IV.56	11,9	16,9	97,8	15,2
Kaliningradskaya	Gusevskiy	1.III.66	30.IV.56	8,4	14,0	87,7	76,6
Latvian SSR	Yelgavskiy	25.III.59	30.IV.55	9,4	11,5	100	79,4
Poltavskaya	Semenovskiy	22.II.66	17.IV.63	9,6	16,4	100	97,4
Belgorodskaya	Urazovskiy	22.III.61	17.IV.63	9,8	10,5	92,0	36,0
Volgogradskaya	Mikhaylovskiy	16.III.66	17.IV.56	11,6	14,0	100	2,6
Kuybyshevskaya	Bagatovskiy	7.IV.66	2.V.48	13,3	19,9	96,3	85,1
Mariyskaya ASSR	Gorno-Mariyskiy	12.IV.51	6.V.52	12,4	15,2	77,8	14,6
Tyumenskaya	Yalutorovskiy	15.IV.66	8.V.52	10,3	16,6	90,9	65,7
Vologodskaya	Vologodskiy	1.IV.66	15.V.58	7,2	13,6	80,2	2,8

Key:
- E) earliest
- L) latest
- A) mean daily temperature during the period from start of of vegetation to tillering at start of vegetation, °C
- B) Number of plants surviving the winter as related to earliest and latest vegetation, %

Thus, in 1971, at the Kozel'shchinskiy strain-testing station in Poltavskaya Oblast, Mironovskaya 808 cultivar at the "shooting" stage formed an average of 2016 roots per 100 plants in the case of natural sprouting time, 1222 roots with artificially delayed sprouting, with 658 and 429 stems, respectively. In 1972, at the same testing station, Mironovskaya 808 and Bezostaya 1 formed a very large leaf surface area (58,000-79,000 m^2/ha [hectare]) in the case of natural and 12 days earlier start of vegetation, whereas in the case of delayed, experimentally induced sprouting the area was considerably smaller (29,600-49,600 m^2/ha). The density of vegetative mass and difference in illumination affected the length of the bottom internodes of the stem, which were elongated (5.1-7.2 cm) in plants that sprouted early and short (1.1-2.7 cm) in those that did so late.

A 15-day delay in vegetation, and particularly a 30-day delay, depressed markedly the formation of photosynthesizing plant surface (Figure 10).

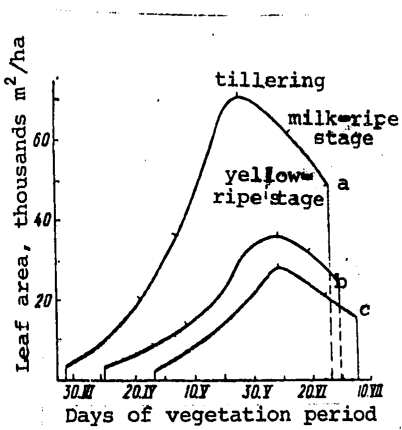

Figure 10.
Effect of time of spring vegetation on leaf surface area in Kavkaz cultivar (Kozel'shchinskiy strain-testing station, Poltavskaya Oblast, 1972). Sprouting time:
a) spontaneous
b) 15-day delay
c) 30-day delay

The photosynthetic potential constituted 3.8 million m^2/days in the case of spontaneous resumption of spring vegetation, and only 1.8 and 1.2 for the later times. In the case of delayed spring vegetation there is a shift in onset of developmental phases and stages of organogenesis to a later time. This involves reduction in duration of not only the vegetative but also reproductive period of plant development.

The crops of the most widespread cultivars respond well to early resumption of spring vegetation (Table 41). In this case, there is formation of rather dense and tall stand of stems, as well as large harvest of dry above-ground mass and grain, with low specific share thereof in the overall mass. The grain is notable for high weight per liter.

Later spring vegetation results in shorter plants, sparser stand of stems at harvesting time, lower yield of dry above-ground mass and grain, but high yield thereof in the overall mass and low weight per liter. The correlation between grain and straw is consistent with the correlation between duration of vegetative and reproductive periods, which are determined by the time of spring vegetation.

In the former case, there is prevalence of vegetative direction of plant growth and development, and in the latter, generative. This situation has a practical application in preparing measures pertaining to spring and summer care of wheat plantings and early prediction of the harvest (V. D. Medinets, 1968; I. I. Garus, P. A. Zabaznyy, I. I. Kovtun, 1970; N. A. Fedorova, 1972, and others).

The reaction of the plants to the time of spring vegetation is also manifested by a change in their winter hardiness. In particular, a rather distinct pattern was demonstrated in Poltavskaya Oblast (V. D. Medinets, 1968), which amounts to the fact that the plantings that suffered in the winter perished in the years of late resumption of spring vegetation (1923, 1929, 1956, 1963, 1964, 1969, 1972, 1976) and were viable in the years of early sprouting (1945, 1951, 1961, 1966, 1971, 1973, 1975, 1977).

Table 41. Reaction of winter wheat cultivars to time of start of spring vegetation (Kozel'shchinskiy strain-testing station, 1969-1973)

Cultivar	Start of vegetation: 9-12 days earlier than usual	usual	delay of 15 days	delay of 30 days
% plants surviving winter				
Mironovskaya 808	97,5	94,4	89,9	79,5
Jubilee Mironovskaya	96,3	93,2	87,0	76,9
Bezostaya 1	89,3	83,6	74,0	60,5
Kavkaz	82,8	77,4	68,0	58,0
Fruit-bearing stems/m^2				
Mironovskaya 808	687	646	500	410
Kavkaz	494	504	316	250
Plant height, cm				
Mironovskaya 808	98	95	36	78
Kavkaz	86	84	78	71
Resistance to lodging, grade (for 1971 and 1973)				
Mironovskaya 808	3	3,5	5	5
Kavkaz	4,5	5	5	5
Dry mass yield, centners/ha				
Mironovskaya 808	139	127	97	73
Kavkaz	128	117	70	90
Grain yield, centners/ha				
Mironovskaya 808	50,7	48,2	38,9	29,4
Jubilee Mironovskaya	54,3	51,7	41,5	31,1
Bezostaya 1	50,1	46,4	31,5	21,6
Kavkaz	52,8	49,7	30,5	21,6
Grain yield, % (not counting 1972)				
Mironovskaya 808	36	37	40	44
Kavkaz	42	42	44	46
Grain weight, g/liter				
Mironovskaya 808	782	785	791	703
Kavkaz	784	774	765	718

Analysis of the data of the State commission for agricultural crop strain-testing made it possible to determine that this phenomenon is observed in many parts of the Soviet Union (see Table 40). Thus, in the period from 1945 to 1970, there were 5 years with late spring vegetation of winter wheat, in 4 of which all of the plantings perished, at the Urazovskiy strain-testing station in Belgorodskaya Oblast. At the same time, when spring vegetation started at an early or average time, the crops did not perish and even failed to thin out over the entire 12 years.

The longer period of winter dormancy and abrupt transition from this state to active vital functions with intensive rise in plus temperatures were the cause of death of the winter crops in the case of late spring vegetation. The rapid temperature rise is more dangerous to plants after the winter than a return to cold weather in the spring (Table 42).

Table 42. Percentage of Mironovskaya 808 cultivars that perished as related to time and conditions of spring vegetation (Lokhvitskiy strain-testing station, 1969)

Variant of experiment	Vegetation started 8 April under natural conditions (open fields)	Vegetation started 29 April after freezing weather, with use of straw for protection
No food supplement	42.6	96.4
N_{60} food in the spring	26.2	41.9

This phenomenon made it possible to validate recommendations to agricultural production on replanting wheat fields that were thinned down by 50% or more as a result of damage in the winter. Thus, in years with late start of spring vegetation, no matter how much water is available in the soil, such areas should be resown; in years of early and optimum resumption of spring vegetation, it is desirable to leave the fields alone, taking into consideration the condition of the plants.

On the basis of the results of experimental studies, a method has been proposed for evaluating winter hardiness of cultivars in the case of artificial delay in spring vegetation (covering the snow on the crops before it starts to thaw with straw or mats). It has been established that the rating of winter hardiness obtained by this method coincides with the evaluations made under natural conditions in inclement years (Table 43). Use of the method of artificially delaying spring vegetation permits evaluation of winter hardiness in years with a mild winter, which is of considerable interest to breeding and strain testing of this crop. The new method of evaluating hardiness of cultivars has been tested in several oblasts, and it is now mandatory at all strain-testing stations.

When winter plantings are covered with polyethylene sheets before the snow begins to thaw, the snow melts rapidly and spring vegetation begins sooner *by an average of 9 days). As shown by the data in the table, this procedure results in better survival of plants that were damaged in the winter. It can be considered as a means of preserving particularly valuable plants for breeding purposes.

Covering sections of a wheat field with polyethylene sheets is also used as a method of field determination of quality of wintering, at the suggestion of the Poltavskaya Oblast inspection office of the State

Commission for Agricultural Strain Testing. For this purpose, snow is removed from field sections each 1 m^2 in size at the end of the winter. They are covered with the plastic sheets, the edges of which are attached to a wood frame. The plants in such sections sprout sooner than usual, which enables us to obtain information about their condition on a given field before the start of eventual resowing. This method of evaluating the condition of winter crops can be used extensively instead of the labor-consuming work of collecting core samples by 15 March at the latest.

Table 43. Percentage of wheat plants that perished as related to different vegetation starting time at the Kozel'shchinskiy strain-testing station

Cultivar	Start of vegetation			
	earlier than usual (crops covered with polyethylene) earlier than usual (crops covered with polyethylene sheets)	usual (control)	later than usual (snow surface on crops covered with straw) 15-20 days later	27-35 days later
1969 (mild winter)				
Bezostaya 1 (awnless)	0	2.9	4.0	19.5
Kavkaz	0	3.7	8.1	21.2
Mironovskaya 808	0	1.4	2.5	11.3
Jubilee Mironovskaya	0	2.0	5.7	13.8
1970 (harsh winter)				
Bezostaya 1	29.3	51.2	80.8	96.9
Kavkaz	62.8	79.4	100	100
Mironovskaya 808	9.6	20.5	31.1	49.5
Jubilee Mironovskaya	12.6	23.9	33.0	51.8

The reaction of winter wheat plants to time of resumption of spring vegetation is also manifested by a change in their resistance to lodging. On this basis, a method was developed for early prediction of lodging of nonresistant cultivars raised in Ukrainian SSR after the best precursors with adherence to the adopted agrotechnology.

Expected lodging graded as at least 4 points (on a 5-point scale of rating resistance) is predicted on the basis of total fall and winter precipitation, which is calculated using the following hyperbolic equation:

$$y \geqslant \frac{4500}{20-x}$$

where y is the total precipitation, in mm, in the period from sowing to resumption of vegetation and x is the deviation from the mean in a given area of start of spring vegetation, in days.

Accuracy of prediction of lodging is about 90%. It can be increased if the actual air temperature during the first 20 days after the plants come out of dormancy is taken into consideration (V. D. Medinets, 1972).

Scientific forecasting of lodging permits effective control of this undesirable phenomenon and, in particular, to use product SSS.

The time that spring vegetation begins also affects the quality of the future grain. In the case of late start, such parameters as hyalinity of the grain, protein and gluten content of grain are high and with an early start, they are considerably lower (V. D. Medinets, 1968, 1970).

The biological essence of this relationship is that the time of resumption of spring vegetation is determined by light and temperature conditions during plant growth up to heading, which in turn determine the nitrogen and protein content of vegetative organs and ripe grain (Tables 44, 45).

Table 44. Protein content of vegetative mass of cultivars, % absolutely dry substance, 1973

Cultivar	Start of spring vegetat.	Strain-testing station and time sample was collected: Kozel'shchinskiy			Lokhvitskiy	
		at start of spring veg.	"shooting" stage	heading stage	start of spring veg.	heading stage
Mironovskaya 808	Early	18,6	20,6	9,7	20,4	10,6
	Late	20,3	26,0	11,4	22,1	12,9
	Deviation	+1,7	+5,4	+1,7	+1,6	+2,3
Jubilee Mironovskaya	Early	20,1	21,1	10,1	—	—
	Late	20,6	26,5	11,6	—	—
	Deviation	+0,5	+5,4	+1,5	—	—
Bezostaya 1	Early	20,6	22,5	10,7	20,3	13,4
	Late	20,9	28,1	10,8	21,1	14,1
	Deviation	+0,3	+5,6	+1,0	+0,8	+0,7
Kavkaz	Early	19,2	20,6	10,2	—	—
	Late	20,4	26,3	10,9	—	—
	Deviation	+1,2	+5,7	+0,7	—	—

Table 45. Quality of Bezostaya 1 grain as related to usual and artificially delayed start of spring vegetation in different years

Parameter of grain quality	Start of spring vegetation	Strain-testing station: Kozel'shchinskiy 1969	Kozel'shchinskiy 1971	Kozel'shchinskiy 1973	Kozel'shchinskiy 1974	Semenovskiy 1972	Semenovskiy 1973	Lokhvitskiy 1970	Lokhvitskiy 1971	Lokhvitskiy 1972
Hyalinity, %	Usual	93	—	—	50	98	100	71	36	74
	Late	95	—	—	54	100	99	88	91	95
	Deviation	+2	—	—	+4	+2	—1	+17	+55	+21
Protein content, %	Usual	13,4	8,7	12,5	14,4	14,2	12,7	11,4	11,3	13,7
	Late	14,4	10,8	14,5	14,9	15,4	14,2	12,6	13,7	15,0
	Deviation	+1,0	+2,1	+2,0	+0,5	+1,2	+1,5	+1,1	+2,4	+1,3
Gluten content, %	Usual	29,5	—	—	32,9	29,8	27,8	25,5	22,5	30,1
	Late	32,5	—	—	34,9	32,4	31,3	27,8	30,0	33,2
	Deviation	+3,0	—	—	+2,0	+2,6	+3,5	+2,3	+7,5	+3,1

Table 46. Mean protein and crude gluten content of commercial wheat grain procured in different oblasts of the Ukraine in years of early and late start of vegetation

Zone and oblast	Protein content, %: start of spring vegetation, late (1963, 1964)	Protein content, %: start of spring vegetation, early (1965, 1966)	Protein content, %: deviation from early veget.	Crude gluten, %: start of spring vegetation, late (1963, 1964)	Crude gluten, %: start of spring vegetation, early (1965, 1966)	Crude gluten, %: deviation from early veget.
Forest-steppe						
Poltavskaya	13,92	11,62	+2,30	22,0	17,0	+5,0
Cherkasskaya	12,70	10,28	+2,41	19,3	14,9	+4,4
Vinnitskaya	12,11	11,07	+1,04	20,3	15,4	+4,9
Khmel'nitskaya	11,93	11,19	+0,74	16,4	12,3	+4,1
Steppe						
Odesskaya	12,93	11,95	+0,98	27,4	22,5	+4,9
Zaporozhskaya	13,98	13,43	+0,55	25,2	22,0	+3,2
Khersonskaya	13,16	12,13	+1,03	23,3	19,6	+3,7
Donetskaya	13,33	12,49	+0,84	24,1	21,9	+2,2

Table 47. Tentative estimate of expected quality of Mironovskaya 808 grain obtained from farms with organized crop rotation and proper system of fertilizers in Poltavskaya Oblast, %

Start of spring vegetation	Total fall-winter precipitation, mm			
	over 200		under 200	
	black fallow ground	after corn for silage	fallow ground	after corn for silage
	Grain protein content, %			
Early	12—13	8—10	13—14	11—12
Late	14—15	13—14	15—16	14—15
	Crude gluten content of grain, %			
Early	24—26	14—17	25—28	17—22
Late	28—31	23—28	30—34	27—31
	Crude gluten content of flour from 70% yield, %			
Early	30—31	20—23	31—32	23—26
Late	34—37	30—34	36—40	34—37

The established correlation between time of spring vegetation of winter wheat and grain quality was confirmed for the production conditions in Poltavskaya and Khar'kovskaya oblasts, as well as southern Ukraine (M. G. Klimov, 1969; G. I. Penigin et al., 1972; A. A. Sobko et al., 1974). It can be illustrated by the data pertaining to the quality of procured [or stored] grain in several Ukrainian oblasts (Table 46).

In the forest-steppe region of the Ukraine and north of this region, the above correlation is more distinct that in areas that are south of 45° north latitude in the European part of the Soviet Union. For example, in the region of Khar'kov, spring vegetation of wheat began very early in 1961 and 1966, on 5-15 March, and late in 1963 and 1964, 5-15 April. According to the data of M. M. Strel'nikova (1971), in the former case wheat grain contained 8-11% protein, 21-24% gluten, and in the latter 15.5-16.6 and 38.5-42%, respectively. In the Stavropol' region (south of 45° north latitutde), the conditions in the spring of these years were about the same as in the Khar'kov area. However, there were virtually no differences in grain quality as a function of start of vegetation (15-16% protein, 26-30% gluten).

This is attributable to the fact that lighting conditions and particularly the presence of short-wave blue-violet rays in the flux of solar radiation are of enormous significance to protein synthesis (Voskresenskaya, 1965; Shul'gin, 1967). In the south (Stavropol'), the intensity of these rays is high, even in early spring, while in the temperate zone (Khar'kov) it increases only in April (when spring is late) and even later in the north.

On the basis of the established influence of time of resumption of spring vegetation on grain quality, a method was proposed for early prediction of protein and gluten content of grain. It consists of the fact that one should expect different qualities of grain, depending on the precursor, precipitation in the fall and winter and time of resumption of spring vegetation. The data in Table 57 can be used for this purpose.

A new method was also proposed for making up batches of grain of good quality (V. D. Medinets, 1968).

Table 48. Conditions of spring development and harvest of winter wheat in a strain-testing competition as related to different times of start of spring vegetation (data from 150 tests at strain-testing stations in the forest-steppe region of Ukrainian SSR over an 11-year period)

Start of spring vegetation, date	Length of day at start of veget., hours	Parameters between start of veget. & heading			Harvest, centners/ha		Grain yield, %	Number of experiments
		mean air temp., °C	FAR*/day, millions kcal/ha	length of period, days	total dry mass	grain		
11—15.III	11,6	8,8	17,6	84	174,0	39,0	22,4	2
16—20.III	11,9	9,4	18,4	78	134,9	42,7	31,7	9
21—25.III	12,3	10,0	18,5	72	119,1	39,3	33,0	18
26—31.III	12,7	10,6	19,2	64	104,6	37,2	35,6	42
1— 5.IV	13,1	11,5	19,7	61	96,6	33,4	34,6	19
6—10.IV	13,5	12,4	20,0	57	89,6	32,6	36,4	24
11—15.IV	13,8	13,4	20,6	53	60,9	24,5	40,2	18
16—20.IV	14,1	14,5	20,7	48	63,4	23,5	37,1	7
21—25.IV	14,4	16,0	21,4	41	54,5	23,6	48,3	1

*FAR--photosynthesis activating radiation [?]

Field tests established that late nitrogen food supplements (during heading) are more effective in years of early start of spring vegetation, whereas early feeding of partly frozen and partly thawed soil is, on the contrary, more effective in years of late spring vegetation. Utilization of nitrogen chiefly for growth processes, as well as worsening of nitrogen metabolism of plants due to mutual shading of plants that are very well-developed in this case are the cause of diminished effectiveness of the nitrogen food supplement.

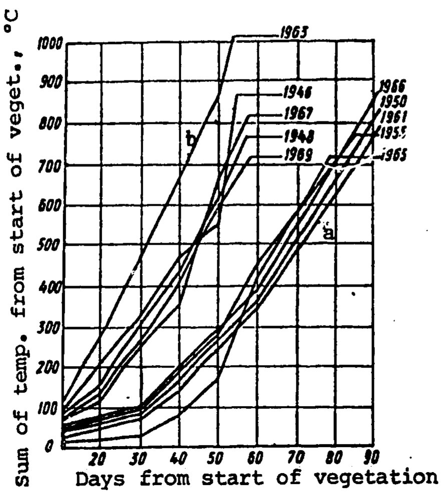

Figure 11.
Accumulation of sum of positive temperatures in years with early (a) and late (b) start of spring vegetation of winter wheat (Semenovskiy strain-testing station, Poltavskaya Oblast)

Thus, it may be concluded that the plants develop into mutually exclusive (opposite) types with regard to their most important qualities with early and late onset of spring vegetation.

The biological reaction of wheat to the time of resumption of spring vegetation is a consequence of its indirect, rather than direct, influence, which affects the crops through factors that have a direct action, light and heat.

In years with early onset of spring vegetation, the plants develop under conditions of a short day, low temperatures and prevalence of orange-red light, which stimulates growth processes. In years with late onset of spring vegetation, the plants are exposed to high and rapidly rising temperatures (Figure 11); they develop under conditions of long days (Table 48) and very high position of the sun, with increase in blue-violet part of the spectrum, which accelerate heading.

Knowledge of the patterns of development of winter plants, as related to time of spring vegetation, enables agronomists to wisely control growth, plant development and formation of plant productivity.

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END